**Prokaryotic and Eukaryotic Cells**

<http://etap.org/demo/biology1/instruction3tutor.html>

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| [**http://www.cod.edu/people/faculty/fancher/ProkEuk.htm**](http://www.cod.edu/people/faculty/fancher/ProkEuk.htm) |
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| As you have already learned, everything that lives is made up of cells. And the cells themselves are made up of many different parts – right down to their molecules.  In fact, what scientists call “the universal principle of life” is defined as the specific interaction of molecules with one another. Now let’s find out a little more about cells and molecules. There are many different cells that do many different things. But all of these cells fall into one of the two main categories: prokaryotic cells and eukaryotic cells.  These cells are more alike than they are different. So first let’s talk about what prokaryotic and eukaryotic cells have in common.    http://etap.org/demo/biology1/Image3.gif**What Prokaryotic and Eukaryotic Cells Have in Common** [**http://www.phschool.com/science/biology\_place/biocoach/cells/common.html**](http://www.phschool.com/science/biology_place/biocoach/cells/common.html)   * Both have DNA as their genetic material (it’s DNA that tells cells what kind of cells they should be). * Both are covered by a cell membrane. * Both contain RNA. * Both are made from the same basic chemicals: carbohydrates, proteins, nucleic acid, minerals, fats and vitamins. * Both have ribosomes (the structures on which proteins are made). * Both regulate the flow of the nutrients and wastes that enter and leave them. * Both have similar basic metabolism (life processes) like photosynthesis and reproduction. * Both require a supply of energy. * Both are highly regulated by elaborate sensing systems ("chemical noses”) that make them aware of the reactions within them and the environment around them.   That's what prokaryotic and eukaryotic cells have in common. But there are significant differences between them too. The two main differences are age and structure. [**Prokaryotic and Eukaryotic Differences**](http://www.slic2.wsu.edu:82/hurlbert/micro101/pages/Chap2.html#Eukaryotic) **Age Differences**  Scientists believe that prokaryotic cells (in the form of bacteria) were the first life forms on earth. They are considered “primitive” and originated about 3.5 billion years ago. That's 2 billion years earlier than eukaryotic cells and billions of years before our earliest ancestors, the hominids.  Here is a brief timeline of the development of life on Earth:   * 4.6 billion years ago the Earth was formed * 3.5 billion years ago the first life arose: prokaryotic bacteria * 1.5 billion years ago eukaryotic cells arose * 0.5 billion years ago the Cambrian explosion – multi-celled eukaryotes arose * 3 million years ago our earliest ancestors, the hominids, appeared   There is strong data to suggest that eukaryotic cells actually evolved from groups of prokaryotic cells that became interdependent on each other. You’ll be learning more about this theory later.    **Structural Differences** [**http://www.cod.edu/people/faculty/fancher/CellStructure.htm**](http://www.cod.edu/people/faculty/fancher/CellStructure.htm)  Eukaryotic cells contain two important things that prokaryotic cells do not: a nucleus and organelles (little organs) with membranes around them.  [**DNA arrangement**](http://digilander.libero.it/avifauna/articoli_ornicoltura/PHTright7.html)Although both eukaryotic and prokaryotic cells contain DNA, the DNA in eukaryotic cells is held within the nucleus. In prokaryotic cells, the DNA floats freely around in a unorganized manner.  [**Presence of organelles**](http://www.biology.arizona.edu/CELL_BIO/tutorials/pev/page3.html)The organelles in eukaryotic cells allow them to perform more complex functions than prokaryotic cells, which don’t have these little organs.  Some of the organelles in eukaryotic cells are: http://etap.org/demo/biology1/Image4.jpg   * The Nucleus – the “brain” or control center of the cell. It contains DNA, which makes up genes. That DNA gets **transcribed**, or copied onto [**messenger RNA**](http://www.biologycorner.com/bio1/DNA.html). That messenger carries a copy of the genes orders for certain protein production. These orders go to the protein factories. * [**Ribosomes**](http://micro.magnet.fsu.edu/cells/ribosomes/ribosomes.html) – These are the protein factories. They follow instructions from messenger RNA (remember that the messenger RNA got its orders from the DNA). The instructions tell the ribosomes to make specific proteins. Note, this particular organelle is found in prokaryotes too! * [**Endoplasmic Reticulum**](http://en.wikipedia.org/wiki/Endoplasmic_reticulum) (ER) – structures that modify proteins produced in the ribosomes. Not all of the proteins made by the ribosomes need changing, but those that do get “altered” here. * [**Golgi Apparatus**](http://en.wikipedia.org/wiki/Golgi_apparatus) – This structure will make even more changes to the proteins that already got changed when they were in the E.R. Remember those proteins were made in the ribosomes, changed once in the E.R. and will be changed again in the Golgi Apparatus. The Golgi also acts as a post office by packaging and shipping proteins to other parts of the cell or out of the cell. * [**Mitochondria**](http://en.wikipedia.org/wiki/Mitochondrion) – structures which produce the cell’s energy, a.k.a. powerhouses of the cell. * [**Chloroplasts**](http://en.wikipedia.org/wiki/Chloroplast) – structures which allow plants to trap sunlight and carry out photosynthesis.   There are some important differences between prokaryotic and eukaryotic cells.  **Size** Eukaryotic cells are, on average, ten times larger than prokaryotic cells.  [**Cell Wall Differences**](http://en.wikipedia.org/wiki/Biological_cell)Prokaryotic cells have a cell wall composed of peptidoglycan (amino acid and sugar). Some eukaryotic cells also have cells walls, but none that are made of peptidoglycan.  [**Flagella Arrangement**](http://www.life.umd.edu/classroom/bsci424/BSCI223WebSiteFiles/Flagella.htm)The flagella in eukaryotic cells are different from the flagella in prokaryotic cells. Flagella are the structures that help cells move (scientists call it motility). The flagella in eukaryotic cells are composed of several filaments and are far more complex than the flagella in prokaryotic cells.  All cells have their genes arranged in linear chains called chromosomes. But eukaryotic cells contain two (or more) copies of every gene. During reproduction, the chromosomes of eukaryotic cells undergo an organized process of duplication called mitosis.    (From <http://www.cod.edu/people/faculty/fancher/ProkEuk.htm>)  The eukaryotic cell developed from the prokaryotic cell. Mitochondria and chloroplasts almost certainly have a similar evolutionary origin. Both are pretty clearly the descendants of independent prokaryotic cells, which have taken up permanent residence within other cells through a well-known and very common phenomenon called endosymbiosis. Many prokaryotic cells have a structure called a mesosome, which is an elaboration of the plasma membrane – a sort of rosette of ruffled membranes intruding into the cell.  http://www.cod.edu/people/faculty/fancher/MesoMit.jpg  The mitochondrion is a double-membrane organelle, with a smooth outer membrane and an inner membrane which protrudes into the interior of the mitochondrion in folds called cristae. This membrane is very similar in appearance to the prokaryotic plasma membrane with its mesosomes. So is there any real evidence that the distant ancestors of mitochondria were independent cells? Quite a lot, actually. Mitochondria (and chloroplasts, for that matter) have their own genetic systems. They have their own DNA, which is not duplicated in the nucleus. Mitochondrial and chloroplast DNA molecules are naked and circular, like prokaryotic DNA. These organelles also have their own population of ribosomes, which are smaller and simpler than the ribosomes out in the general cytoplasm. Mitochondria and chloroplasts also divide on their own, in a manner similar to the binary fission of prokaryotic cells.  **CHARACTERISTICS OF BACTERIA**  Review of differences between prokaryotes and eukaryotes:   |  |  |  | | --- | --- | --- | | **Property** | **Eukaryote** | **Prokaryote** | | True nucleus |  |  | | DNA |  |  | | Cell division |  |  | | Ribosomes |  |  | | Mitochondria |  |  | | Chloroplasts |  |  | | Flagella |  |  | | Size |  |  | | Microorganism examples | *Amoeba, Euglena, Paramecium* | *E. coli, Bacillus anthracis* |   Bacteria are \_\_\_\_\_karyotes. They can be divided into two groups, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are unique, because they share traits with eukaryotes and eubacteria.  Archaebacteria  Three major groups of Archaebacteria are: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ live in extremely hot environments, like hot sulphur springs. An important biotechnological enzyme comes from one of these species, *Thermus aquaticus*.  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ live in oxygen-free environments, such as swamps, and the intestines of animals; they produce methane gas. These are important in cleaning sewage leaks, and oil spills.  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ live in very salty conditions. Protein from these bacteria may be used in a test to detect some cancers.  Eubacteria  These can be generally broken down into one of two groups, based on characteristics of the molecules that make up the \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_. One of these molecules is a polymer called peptidoglycan, and the presence, or absence, of this polymer is detected by the \_\_\_\_\_\_\_\_\_\_ staining method. Bacteria whose cell walls contain peptidoglycan will stain a violet colour, while those without that polymer will stain red. We call the bacteria that contain peptidoglycan, and turns violet, Gram \_\_\_\_\_\_\_\_\_\_\_\_, and those without peptidoglycan in the cell wall, and stain red, Gram \_\_\_\_\_\_\_\_\_\_\_\_\_.  It is difficult to apply the Gram method to Archaebacteria, because, even though the cell walls do not contain peptidoglycan, some have similar compounds that react with the staining solution, in unpredictable ways.  [Description: Bacteria Cell Clip Art](javascript:edit(29949))  Other Ways to Compare Eubacterial Species  Species can be classified according to cell shape, cell configuration, type of respiration, and type of nutrition.  The three basic cell shapes are: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Cocci), \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Bacilli), and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Spirilla).  The Cocci and Bacilli can form several configurations of cells: \_\_\_\_\_\_\_\_\_\_\_\_ (Monococcus, Monobacillus), \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Diplococcus, Diplobacillus), \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Streptococcus, Streptobacillus), \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Staphylococcus only), and others.  Some bacteria, such as those causing tuberculosis, require oxygen for cellular respiration. They are described as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Other bacteria, such as those that cause gangrene and tetanus, only grow when no oxygen is present. They are described as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Many bacteria can grow with or without oxygen. This group includes *E. coli*.  Some Eubacteria are autotrophic, performing either \_\_\_\_\_\_\_\_\_\_synthesis or \_\_\_\_\_\_\_\_\_\_synthesis. Most Eubacteria are \_\_\_\_\_\_\_\_\_\_trophic, feeding off of either living or dead tissues.  Reproduction in Eubacateria and Archaebacteria  Bacteria reproduce asexually by binary fission.  A form of sexual reproduction called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ exists among certain species, including *E. coli*. In this process, small, circular pieces of DNA called \_\_\_\_\_\_\_\_\_\_\_\_ are exchanged from one bacterium to another by means of a sex pilus. These circular sequences of DNA offer to give new characteristics (e.g., antibiotic resistance) to the recipient cell.  Some bacteria are able to survive unfavourable or dangerous environmental conditions by forming a ‘sleeping’ cell, called an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. They are resistant to heat, and other extreme environments, and the cell can reactivate itself when conditions become more favourable.  Match the bacterial classification with observations that were made in the laboratory.  \_\_\_ 1. Methanogen  \_\_\_ 2. Halophile  \_\_\_ 3. Gram-negative Streptobacillus  (*E. coli*)  \_\_\_\_4. Gram-positive Staphylococcus  \_\_\_\_5. Gram-negative Anaerobic  Diplobacillus  \_\_\_\_6. Gram-positive Autotrophic  Spirilla  A) Rod-like cells stain red and form in pairs, only in absence of oxygen.  B) Cells stain violet. Cells form a clump of spherical-shaped cells.  C) Gram stain inconclusive. Dies when exposed to oxygen. Performs reaction  carbon dioxide + hydrogen gas → methane + water.  D) Cells stain red. Cells form a chain of rod-like cells. Grows in air, and in air-tight  incubation chamber.  E) Gram stain inconclusive. Grows best on high concentrations of sodium chloride, and  will not survive below an upper threshold of salt.  F) Organisms look like a corkscrew, and stain violet. Cells have a green appearance.  [Description: File:Bacterial morphology diagram.svg](//upload.wikimedia.org/wikipedia/commons/6/69/Bacterial_morphology_diagram.svg) |

**VIRUSES**

It is difficult to conclude if viruses are alive or not. On their own, viruses do not perform any metabolic functions, and they cannot reproduce. Viruses are able to reproduce once they have entered a living cell.

The size of viruses is usually measured in nanometres (1 x 10-9 metres), whereas living cells are usually measured in micrometres. Viruses can, therefore, be about one thousand times smaller than living cells, including bacterial cells.

Most viruses consist of a nucleic acid core (either DNA or RNA), and are surrounded by a protein coat called the capsid. The arrangement of the capsid proteins gives the virus its shape.

Viruses are usually selective about the types of cells that they can infect. This is referred to as the virus’ host range, that is, the species, tissues, and cells of an organism that can be infected.

For example, the rabies virus has a wide host range because it infects many species of animals. The human cold virus has a relatively narrow host range, that is, cells of the upper respiratory tract. HIV binds to specific proteins on the surface of white blood cells, giving it a narrow host range.

There are four basic steps to viral replication:

1. Attachment and entrance:- the virus recognizes a specific molecule on the surface of a host cell, and attaches to the surface of the cell. Then, either the entire virus enters the cell, or just the genetic material (DNA or RNA) does.

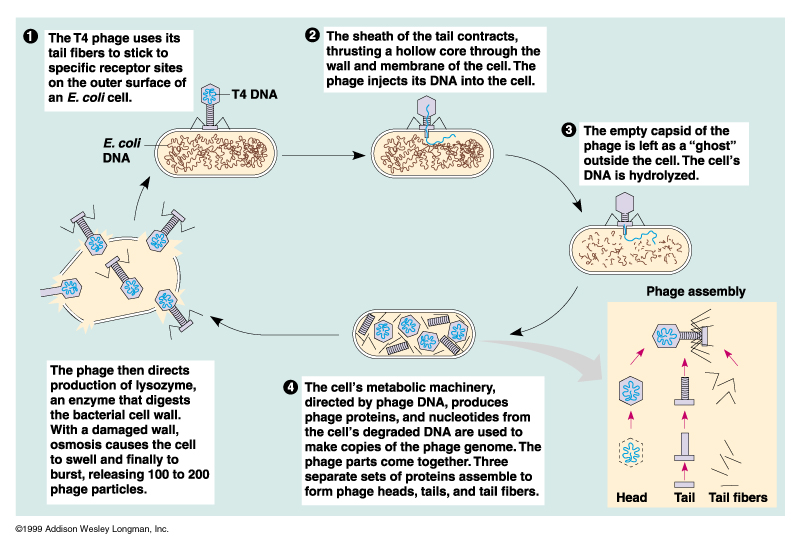
2. Synthesis of Protein and Nucleic Acid:- genetic information in the virus’ DNA or RNA ‘orders’ the host cell to use its cellular components to produce viral nucleic acids, enzymes, capsid proteins, and others.

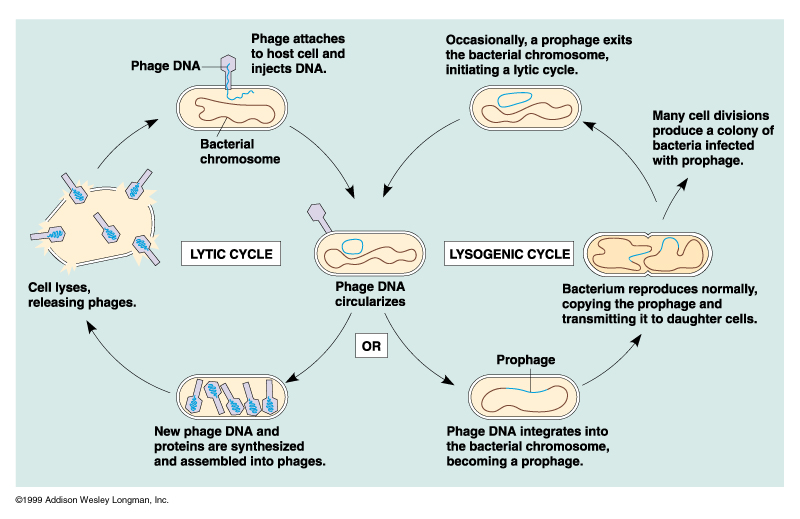
3. Assembly of the Viral Units:- the replicated viral nucleic acid, and viral proteins, are packaged together to make individual virus particles.

4. Release of New Virus Particles:- the host cell dies as the newly-assembled virus particles leave. This is called lysis.

This “lytic” replication cycle can be completed within 25 to 45 minutes.

Certain viruses undergo a “lysogenic” replication strategy, notably, those that infect bacteria, and those that can cause cancer. In the lysogenic cycle, the viral nucleic acid can become integrated into the DNA of the host cell, and, then, passed down to all the daughter cells of that infected cell. This dormant state of sleep is called lysogeny. The “sleeping” virus can be triggered to reactivate in response to a significant environmental change. The trigger induces the lytic cycle again.



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When host cells are destroyed during the process of viral replication, the result is the symptoms of disease or illness. Viruses are difficult to treat directly, because they do not respond to antibiotics. Also, some viruses are dormant in the body for years before the symptoms of disease appear; some viruses, such as those that undergo lysogenic replication, can cause cancer by adding their DNA to the host DNA. Vaccines, which contain dead, or weakened, virus particles, can stimulate the host immune system to fight the invading virus.

Example Virus – Influenza

Single-stranded RNA virus

Sphere-like capsid body with protein spikes

Three influenza types: A, B, C, depending on physical and chemical differences

Strains of influenza are described by the protein coat, the year of isolation, and geographic location

The first hosts of the virus are tissues of the lungs and throat. When cells with cilia are destroyed, mucus and foreign particles accumulate in the respiratory tract.

Various other symptoms accompany the sore throat and congested lungs.

An influenza vaccine can be up to 90% effective in preventing illness from a specific influenza virus. Because the protein in the coat evolves as the virus moves from country to country, new vaccines must be developed and used every year.

**PROTISTS**

Protists have extremely diverse biological characteristics and live in diverse habitats. There are three distinct groups in the kingdom of protists. These are: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (protozoa), \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (protophyta), and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Members of these three groups have the following in common:

Most are \_\_\_\_\_cellular. A few are \_\_\_\_\_\_\_\_cellular, but do not form distinct tissues.

The cells are \_\_\_\_\_karyotic (nucleus surrounded by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_).

The cells reproduce asexually by \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_. Some exchange DNA as a form of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ reproduction.

The cells grow well in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ surroundings, such as fresh water, salt water, or animal fluids.

Plant-like Protists

These organisms perform \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because they possess the green pigment \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ . In the dark, the cells can switch from being autotrophic to \_\_\_\_\_\_\_\_\_trophic.

Example of plant-like protists: *Euglena*. Features include: Eyespot – detects \_\_\_\_\_\_\_. Two flagella, no cell wall, plasma membrane surrounded by firm, yet flexible, covering called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Food is stored in the form of \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_.

Another example of plant-like protists: **algae** (green, brown, and red). They are \_\_\_\_\_\_\_\_\_cellular, but do not form tissues, as opposed to higher plants.

Algae are adapted to \_\_\_\_\_\_\_\_\_\_\_\_\_ environments. In addition to water, they can be found in soil, lower tree trunks, and on rocks.

Brown and red algae are commonly called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which are large, multicellular ocean plants. They contain \_\_\_\_\_\_\_\_\_\_\_ that let them carry out photosynthesis with the wavelengths of light available at specific depths of water. Single-celled green algae are often referred to as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, near the water surface.

Algae reproduce in a variety of ways.

Algae are the main producers of energy in aquatic food chains. By their photosynthesis, they supply about 80% of the world’s \_\_\_\_\_\_\_\_\_\_\_\_\_. Too little algae, or too much, can be a big problem for aquatic ecosystems.

Algae are used by humans as a source of food, and products that come from algae are important in many industries. Algae also helped produced many \_\_\_\_\_\_\_\_ deposits.

Animal-like Protists

All are \_\_\_­­\_\_\_\_\_trophs. Classified according to methods of \_\_\_\_\_\_\_\_\_\_\_\_\_\_: pseudopods, flagella, cilia, or reliance on body fluids of host (the completely parasitic sporozoa).

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| --- | --- | --- | --- |
| Organism | Amoeba | Paramecium | Sporozoa (e.g., Plasmodium) |
| Locomotion | Pseudopod | Cilia (arm-like for swimming) | No independent locomotion |
| Structural Features | Cytoplasm has outer layer (ectoplasm), and inner layer (endoplasm) | Trichocysts – poison tips for defence, or to capture prey  Two nuclei – macro nucleus controls cell activities, micronucleus assists in reproduction. | Fewer organelles and specialized structures than most protozoans. |
| Reproduction | Binary fission (one per day) | Binary fission; sometimes sexual by conjugation. | Asexual formation of spores in animal tissues. Spores are haploid. |
| Feeding | Phagocytosis – food digested in food vacuole. | Cilia direct food into oral groove, ultimately into gullet and food vacuole. Wastes expelled through anal pore. |  |
| Other |  | Lives in fresh, and salt water. Under bad environmental conditions, can form resting cells called “cysts”. |  |

Disease-causing animal-like protists

*Plasmodium* – a sporozoan, causes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, is spread to humans by *Anopheles* mosquitoes. The mosquito is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that transmits the disease from one host to another. Most effective way to prevent disease is to eliminate the vector.

*Entamoeba* – causes amoebic dysentery. Organism lives, and feeds on, the wall of the \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_. Disease spreads when the amoeba forms cysts that leave the body via feces, and contaminates food and water. In countries where amoebic dysentery occurs, many humans possess the organisms without having any symptoms of illness. These people are called \_\_\_\_\_\_\_\_\_\_\_\_\_ of the disease.

*Trypanosoma* – causes African sleeping sickness. It is transmitted by \_\_\_\_\_\_\_\_\_\_\_\_ fly. Growing in human blood, it releases toxins that affect the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and lymphatic systems.

Fungi-like Protists

Also referred to as \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_. They prefer to live in shaded, cool, and moist habitats; usually found under, or on, rotting leaves or logs.

At some times, slime moulds resemble animal-like protists, and move like amoebae, or use flagella. At other times, they produce \_\_\_\_\_\_\_\_\_\_\_, like fungi.

Slime moulds do not only remain as single cell organisms, the cells can converge into a large slimy mass.

**MICROORGANISMS IN ECOSYSTEMS**

Many microorganisms obtain their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ through symbiotic relationships with other living things in their environment. There are three types of symbiotic relationships: \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Parasitism is identified as a +/\_\_\_ relationship where one species benefits (the \_\_\_\_\_\_\_\_\_), and the other (the \_\_\_\_\_\_\_\_\_) is harmed. All \_\_\_\_\_\_\_\_\_\_\_\_\_-causing microorganisms, including viruses, are parasites.

Example: Oral bacteria in the human mouth digest sugars and produce lactic acid that dissolves tooth enamel, causing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Commensalism is identified as a +/\_\_\_ relationship, where one species benefits, and the other is neither helped nor harmed.

Example: *Corynebacterium* lives on the surface of the human \_\_\_\_\_\_\_\_\_, feeding on secretions from that organ. The human is neither helped nor harmed.

Mutualism is identified as a \_\_\_/\_\_\_ relationship, where both partners benefit. Species are so interconnected that, often, one’s lifecycle cannot be completed without the other.

Example: *E. coli* and human intestines produce \_\_\_\_\_\_\_\_\_\_\_\_ for humans; *Rhizobium* bacteria in the root of legumes; protozoans in the gut of termites.

Agriculturalists use a process called “effective microorganisms” (EM), which is a mixture of \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_. Application of these organisms improves soil structure and fertility, reduces the need for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and increases \_\_\_\_\_\_\_\_\_\_\_\_\_\_. EM is also used in aquaculture, livestock production, and recycling.

Pesticides are used to control insects, diseases, weeds, and microorganisms on agricultural products. They are designed to attack particular pests without affecting \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ organisms. However, widespread use has shown that, when one species in an ecosystem is affected, so is the diversity of organisms. Any measure that reduces soil \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ also reduces nutrient cycling and affects plant growth.

Many Canadian cities now use integrated pest management (IPM), which is a combination of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, to control pests in their parks, and open areas.

**SYMBIOTIC RELATIONSHIPS**

*Please place*

COMMENSALISM (C) PARASITISM (P) MUTUALISM (M)

\_\_\_\_\_ barnacle/whale Barnacles create home sites by attaching themselves to

whales. This neither harms nor benefits the whales.

\_\_\_\_\_ mistletoe/spruce tree Mistletoe extracts water and nutrients from the spruce tree

to the tree’s detriment.

\_\_\_\_\_ yucca plant/yucca moth Yucca flowers are pollinated by yucca moths. The moths

lay their eggs in the flowers where the larvae hatch and eat

some of the developing seeds. Both species benefit.

\_\_\_\_\_ hermit crab/snail shell Hermit crabs live in shells made and then abandoned by

snails. This neither harms nor benefits the snails.

\_\_\_\_\_ oxpecker/rhinoceros Oxpeckers feed on the ticks found on a rhinoceros. Both

species benefit.

\_\_\_\_\_ cowbird/buffalo As buffalos walk through grass, insects become active and

are seen and eaten by cowbirds. This neither harms nor

benefits the buffalos.

\_\_\_\_\_ mouse/flea ` A flea feeds on a mouse’s blood to the mouse’s detriment.

\_\_\_\_\_ wrasse fish/black sea bass Wrasse fish feed on the parasites found on the black sea

bass’s body. Both species benefit.

\_\_\_\_\_ deer/tick Ticks feed on deer blood to the deer’s detriment.

\_\_\_\_\_ silverfish/army ants Silverfish live and hunt with army ants They share the prey.

They neither help nor harm the ants.

\_\_\_\_\_ cuckoo/warbler A cuckoo may lay its eggs in a warbler’s nest. The

cuckoo’s young will displace the warbler’s young and will

be raised by the warbler.

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\_\_\_\_\_ honey guide bird/badger Honey guide birds alert and direct badgers to bee hives.

The badgers then expose the hives and feed on the honey

first. Then the honey guide birds eat. Both species benefit.

\_\_\_\_\_ hookworms/humans Hookworms enter the human body by burrowing into the

skin of the feet. Once in the skin they enter the bloodstream

and travel to the small intestine where they attach to the

walls and begin to the drink the person’s blood and weaken

the victim.

\_\_\_\_\_ kapoc trees/orchids Types of orchids grow high on the branches of the tall

kapoc trees of the jungle. This adaptation allows the orchid

to receive enough sunlight to perform its photosynthesis but

the kapoc trees are unaffected.

\_\_\_\_\_ lichen algae/lichen fungus Lichens are close associations of fungi and algae. The fungi

hold the water supply and the algae perform photosynthesis

and manufacture the carbohydrates for both.

\_\_\_\_\_ acacia tree/ants In the jungles of South America live a thorn tree called an

acacia. A species of ant eats secretions of the acacia, drink

its sap, and raise its young in the hollow thorns. The ants

also keep competing vines from growing near the acacia

tree and they help repel any insects that would damage the

acacia.

\_\_\_\_\_ moose/tapeworm In the flesh of the moose are the cysts (dormant stage) of a

worm that makes the muscles of the moose stiff and sore. If

the moose is killed and eaten raw, the predator species will

develop a form of tapeworm.

\_\_\_\_\_ lactobacilli/humans Lactobacilli are a type of bacteria that live in our lungs and

destroy many of the microorganisms that enter our

respiratory system. They are highly adapted to living in our

lungs and can’t survive in many other habitats.

\_\_\_\_\_ soybeans/bacteria Soybeans require nitrogen from their environment. This

nitrogen is provided by bacteria that live in special root

nodules. In return, the bacteria receive some of the sugar

(carbohydrates) manufactured by the soybeans.

**HELPFUL AND HARMFUL BACTERIA**

Helpful Features of Bacteria

Bacteria recycle dead organic material. These organisms are referred to as **saprophytes** . Otherwise, food chains would be broken; producers would not have enough nutrients to grow, and consumers would have nothing to eat.

Bacteria are used in the process of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, in order to remove pollutants from the environment. For example, a bacterium from the genus *Flavobacterium* is able to use a toxic wood preservative (penta-chlorophenol) as a nutrient for its growth. It is much \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to clean contaminated soil with *Flavobacterium* rather than burning away the contaminant. Another advantage of this strategy is that, once the contaminating chemical is used up, the bacteria die.

Many bacteria have the potential to maintain human health, and prevent disease; they are referred to as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These may be added to \_\_\_\_\_\_\_\_, or used in the treatment of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (ear, intestinal, urinary tract). They may, also, be used to reduce blood \_\_\_\_\_\_\_\_\_\_\_\_\_\_ levels, and to actually prevent tooth decay, and some cancers.

During their metabolism, bacteria produce \_\_\_\_\_\_\_\_\_\_\_ that are helpful to many people. It is usually less expensive to use intact bacteria than enzymes isolated and prepared from these organisms.

Harmful Bacteria Case Studies – Walkerton, Ontario

Bacteria cause a variety of diseases, including Anthrax, Legionnaires ’ disease, Diphtheria, Typhoid Fever, Bubonic Plague, Tuberculosis, etc.

In May of 2000, bacteria from the \_\_\_\_\_\_\_\_\_\_\_\_ of cattle were washed into the well water of Walkerton, Ontario. Symptoms of illness included: vomiting, cramps, bloody diarrhea, and fever. The drinking water was contaminated with the *E. coli* strain O157:H7.

The combination of numbers and letters in the name O157:H7 refer to specific markers found on the \_\_\_\_\_\_\_\_\_\_\_ of the bacterium. This strain produces a toxin that the immune system of a healthy adult can fight in five to ten days, without special \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The toxin can kill young children and the elderly; effects include: destruction of red blood cells, kidney failure, seizures, or strokes.

The main source of O157:H7 is undercooked \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_, which can be contaminated with feces as the meat is being processed. Other sources of this strain include: processed meat, sprouts, leafy green produce, unpasteurized milk and juice, and contact with cattle. Also, it can be spread by swimming in\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_, or drinking \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ water. The bacterium is easily transmitted from \_\_\_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_.

Proper \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the water may have been able to save the lives of seven people who died in Walkerton. Ultraviolet (UV) light can also be used to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the water.

Bacteria cause illness in a variety of ways. In Walkerton, toxins overloaded the body’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_ system. In some cases, the sheer number of invading bacteria place high stress on the host’s normal tissues. Some bacteria destroy cells and tissues.

Helpful Bacteria – Table

|  |  |
| --- | --- |
| **Type of Bacteria** | **Beneficial Effect** |
| *Clostridium* | Produces butanol and acetone from molasses |
| *Acetobacter* | Produces vinegar from ethanol |
| Intestinal bacteria | Food digestion; synthesis of vitamins for humans |
| *Lactobacillus* | Produces lactic acid from sugar; prevents growth of harmful bacteria in dairy products |
| *Azotobacter, Nitrobacter* | Nitrogen fixing in soil |
| *Streptococcus* | Production of dairy products |
| *Streptomyces* | Soil bacteria; source of antibiotics |
| *Pseudomonas* | Clean up of waste in sewage treatment |
| *Bacillus* | Soil bacteria, natural pest killer |

Harmful Bacteria – Table

|  |  |
| --- | --- |
| **Type of Bacteria** | **Disease/Destruction Produced** |
| *Clostridium* | Botulism, tetanus, gangrene |
| *Streptococcus* | Strep throat, scarlet fever, pneumonia |
| *Staphylococcus* | Boils; food spoilage; food poisoning; skin, blood, and eye infections; pneumonia |
| *Lactobacillus* | Souring of milk |
| *Pseudomonas* | Gasoline spoilage; food spoilage; blood infections; eye infections |
| *Bacillus* | Destruction of silk worms, tuberculosis, anthrax |
| Coliform bacteria | Pollution of water sources, soft rot in plants, gastroenteritis, dysentery |
| *Spirillum* | Syphilis |

**MICROBIOLOGY TEST REVIEW**

Section 2.4 Bacteria

1. Be able to compare the features of prokaryotic and eukaryotic organisms. Describe the appearance, or presence/absence, of the following features in each type of organism: internal organelles, nuclear membrane, nucleolus, endoplasmic reticulum, mitochondria, chloroplasts, ribosomes, relative cellular size, type of cell division, features of DNA, including types of protein associated with the nucleic acid.

2. What are three major groups of archaebacteria? Where are they found, and how do they live there, that is, what features have they developed to survive in those environments?

3. What are some ways humans can use features of archaebacteria, in industry, health care, etc.?

4. How do *E. coli* living in our intestines help us?

5. What is the Gram Staining method? What does it, specifically, test for, and how do health care workers, and scientists use it?

6. What is the difference between aerobic metabolism and anaerobic metabolism? Where can you find examples of these bacteria?

7. Define the following terms: binary fission, conjugation, endospore.

Section 2.3 Viruses

1. What does a virus consist of? How is it similar to, and different from, living cells?

2. What is a host range? How many species can a specific virus invade?

3. Describe the lytic, and lysogenic, viral replication cycles, and which viruses tend to use them.

4. How can we treat viral infections? How effective are antibiotics against them? What are vaccines?

5. Why are new influenza vaccines needed every year?

Section 2.13 Protists

1. What are the three major groups of protists?

2. Describe features of *Euglena* that are similar to multicellular plants, and those which are not.

3. Describe the three groupings of algae. Why are algae important?

4. Based on what specific feature are the animal-like protists (protozoa) grouped?

5. Compare movement, feeding methods, and reproduction methods used by amoeba, *Paramecium*, and Sporozoa.

6. Describe the life cycle of plasmodium, including a statement about which human disease it causes.

7. Describe the concept of a “carrier” for a disease, using the example of amoebic dysentery.

8. Explain how slime moulds partially resemble both protists and fungi.

Section 2.15 Fungi

1. Compare and contrast features of fungi and plants.

2. Describe the roles of spores and mushrooms in asexual and sexual reproduction in fungi.

3. What uses do humans make of fungi?

4. Explain the symbiotic relationships observed in both mycorrhizae and lichens.

Section 2.17 Microorganisms in Ecosystems

1. Define, and give examples of, the three symbiotic relationships described in this section.

2. Explain how the use of pesticides to remove unwanted organisms, can, ultimately, kill off beneficial organisms, and make crops more susceptible to disease.

3. What is Integrated Pest Management (IPM)?

Sections 2.7 and 2.8 Helpful Bacteria and Harmful Bacteria

1. Define the terms “saprophytes” and “bioremediation”, and explain how bacteria contribute positively to the environment in these activities.

2. Provide examples of the use of bacteria in various industries.

3. Use the example of the Walkerton tragedy to contrast “good” and “bad” *E. coli*. Discuss ways in which this event could have been prevented.